Implications of rising sea level for the mid-Atlantic

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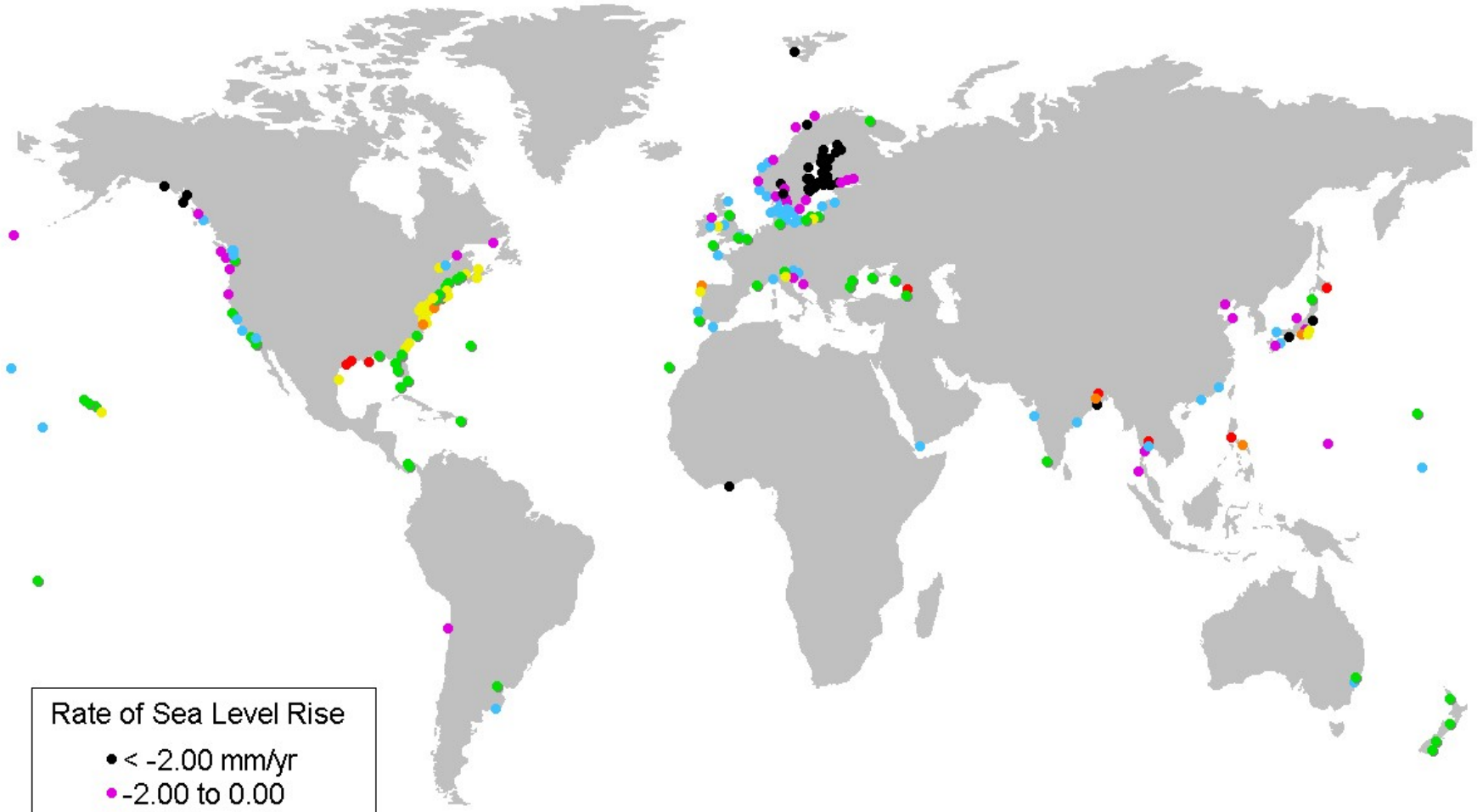
Black and Purple: sea level fall

Blue: sea rise less than average



Green: Average

Yellow: Sea rising faster than average

Orange and Red: 2 to 5 times average

Impacts of Sea Level Rise

- Inundation
  - Dry land
  - Wetlands
- Erosion
- Flooding
- Saltwater Intrusion

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  - Wetlands
- Erosion
- Flooding

Three Responses to Sea Level Rise

- Retreat
- Hold Back the Sea:
  - Armor the Shore (dikes, seawalls, bulkheads, rip-rap) *or*
  - Elevate Land Surfaces

Environmental Impacts of Sea Level Rise

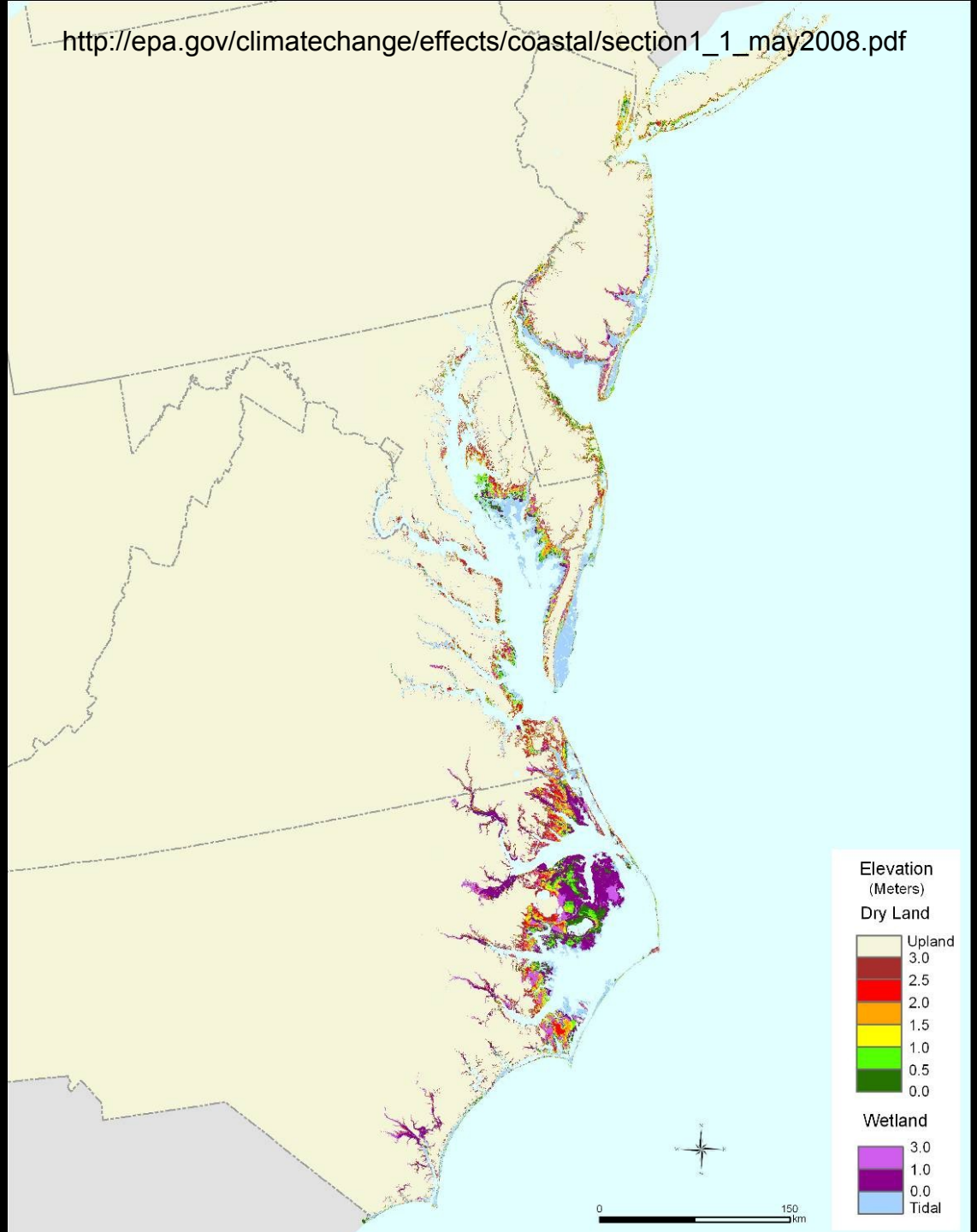
The Rise Itself

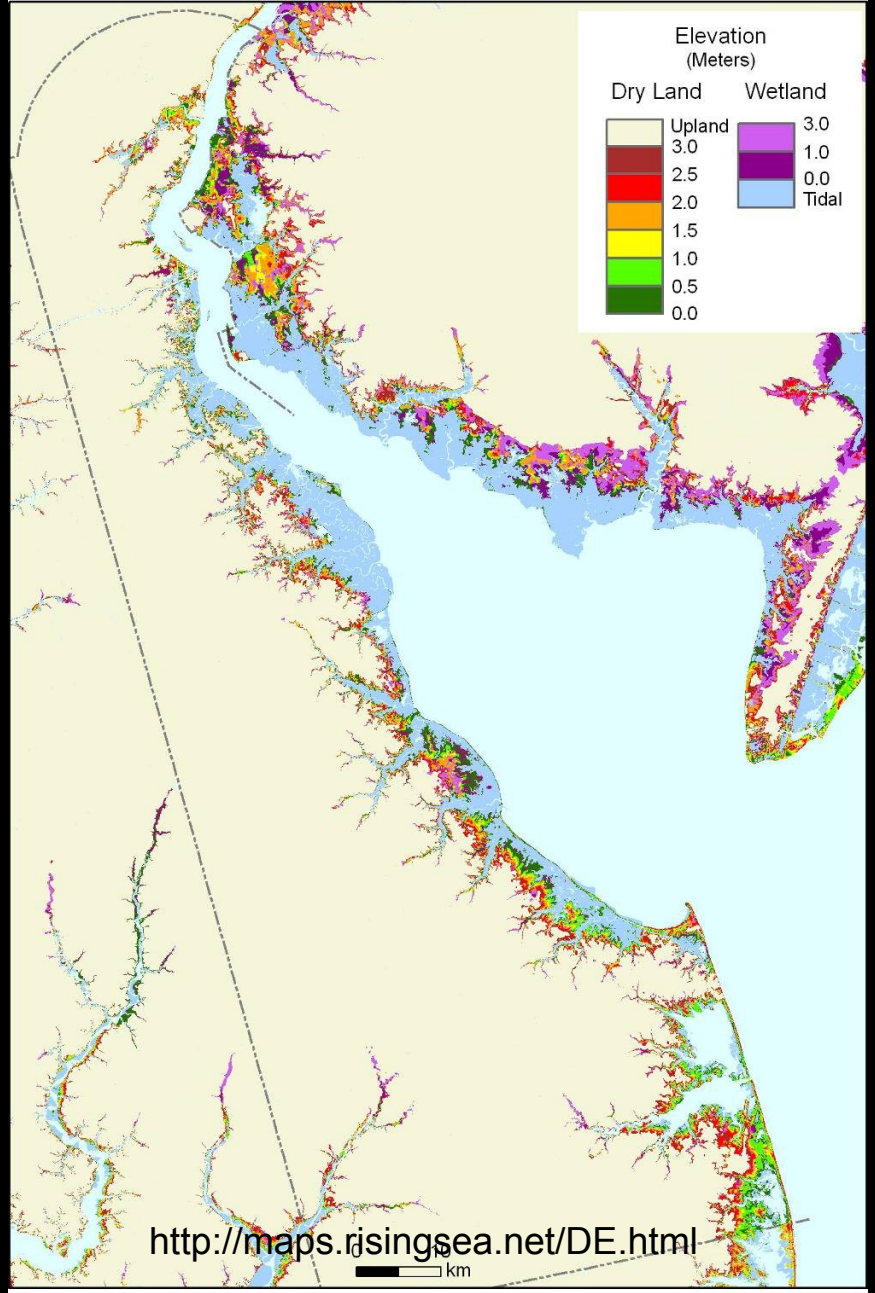
- Wetland Inundation
- Erosion of beaches, mudflats and wetlands
- Saltwater intrusion into estuaries, groundwater, and wetlands
- Water Tables-->Septics
- Higher water

Effects of Response Strategies

- Shoreline armoring
  - Net wetland loss
  - Lose Estuarine Beaches
  - Lose mudflats and shallows
  - Lost public access along shore
- Failed septics induce infrastructure

http://epa.gov/climatechange/effects/coastal/section1_1_may2008.pdf

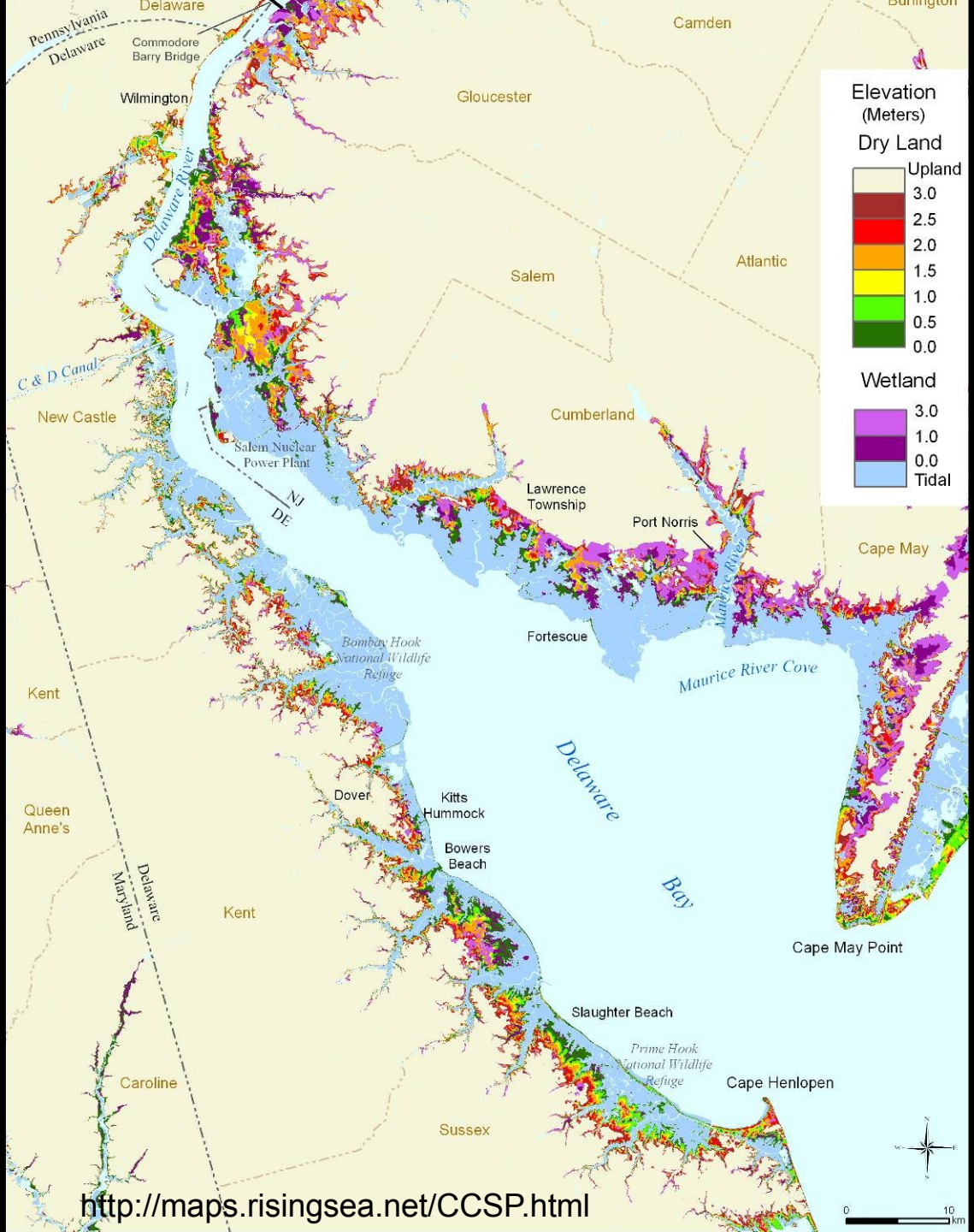




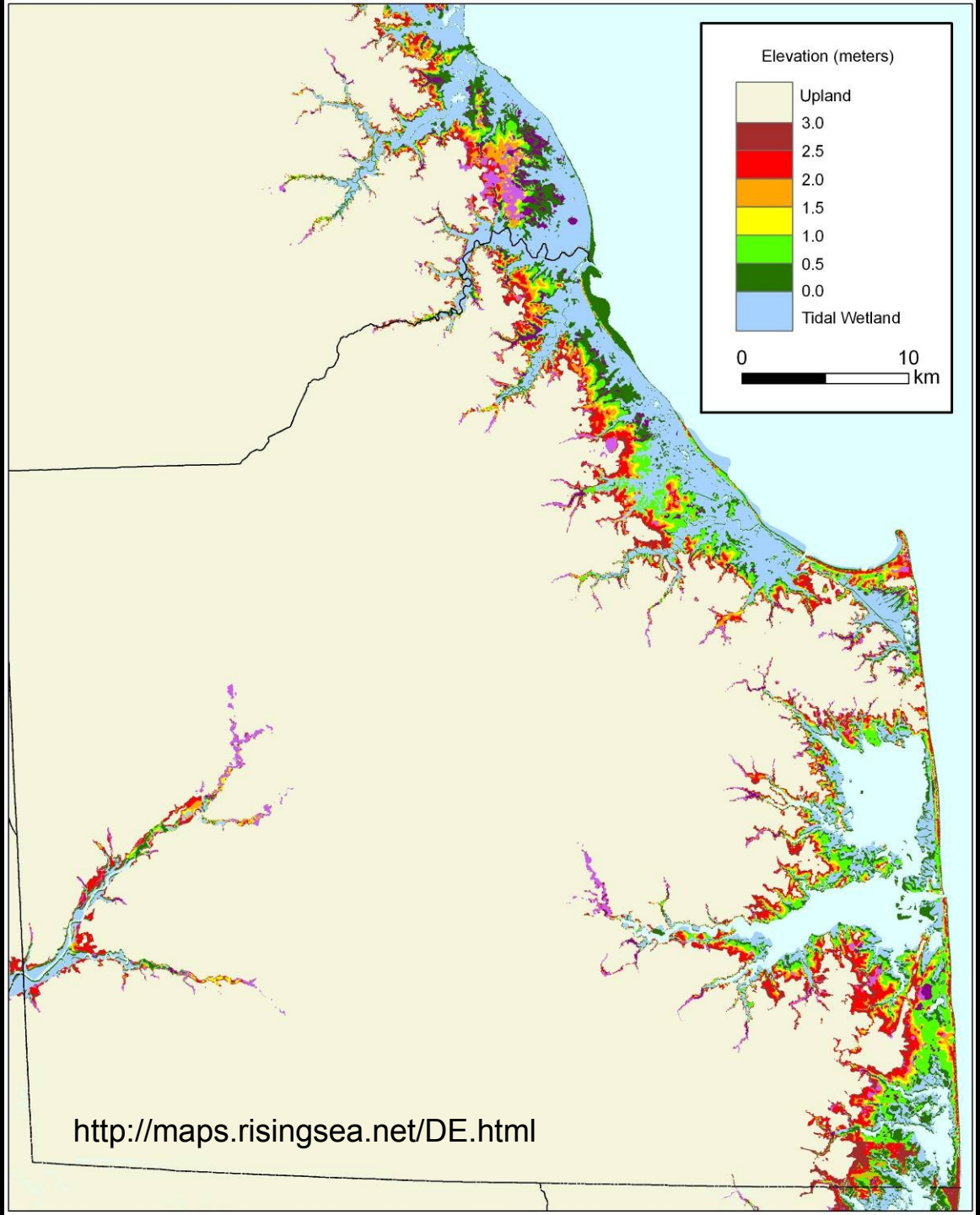
Elevations of Land Close to Sea Level

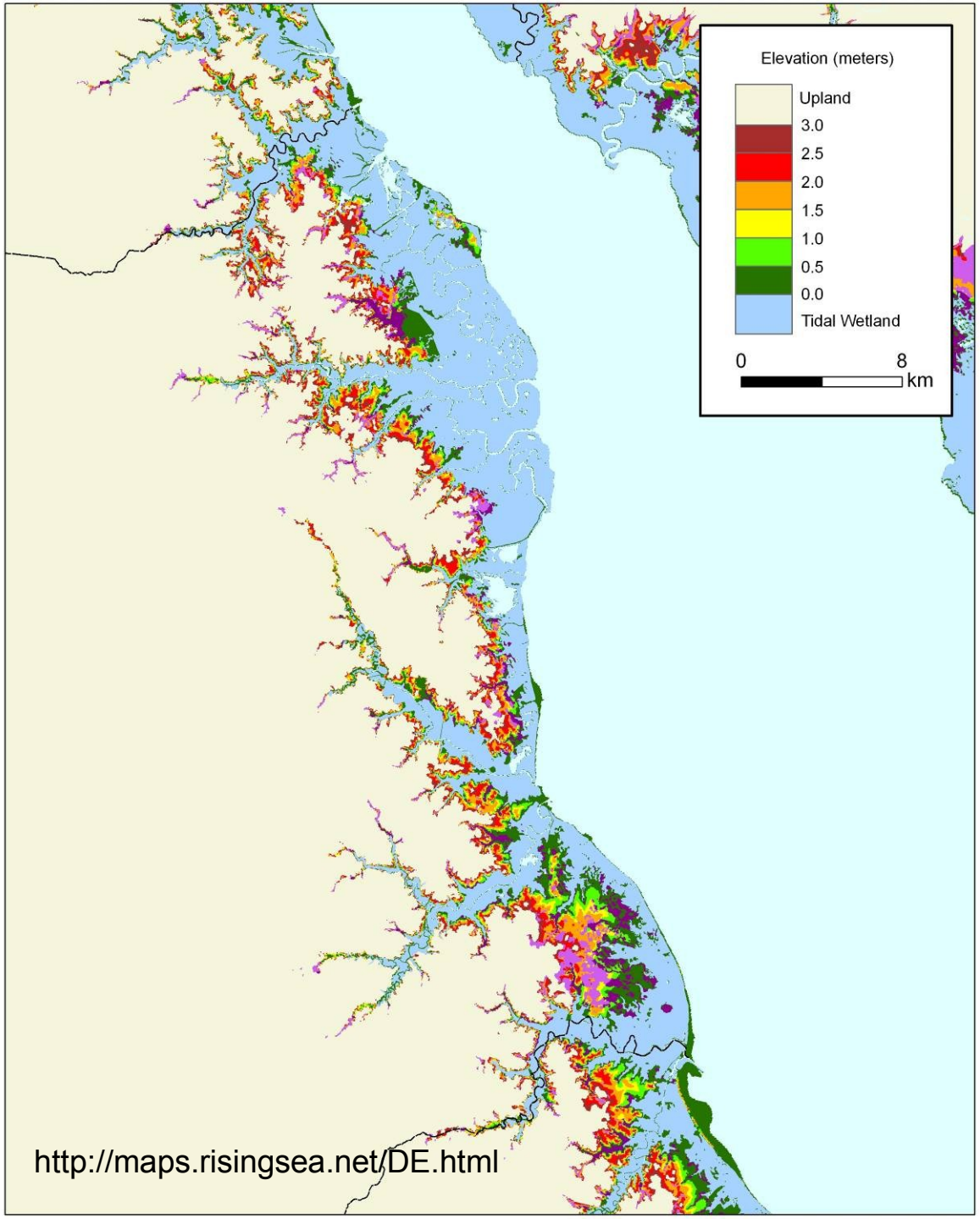
Elevations are above spring high water, which is the average high tide during new and full moons, and approximately the inland boundary of tidal wetlands. This map is a general graphical representation of elevations in the area depicted, not designed to estimate the precise elevations at specific locations. Elevations at specific locations are generally within 75 cm above or below the elevation depicted.

Source: J.G. Titus and J Wang. 2008. "Maps of Lands Close to Sea Level along the Mid-Atlantic Coast". US Environmental Protection Agency.



http://maps.risingsea.net/CCSP.html


Elevation (meters)
Upland
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Tidal Wetland
0
10
km
http://maps.risingsea.net/DE.html


Elevation (meters)
Upland
3.0
2.5
2.0
1.5
1.0
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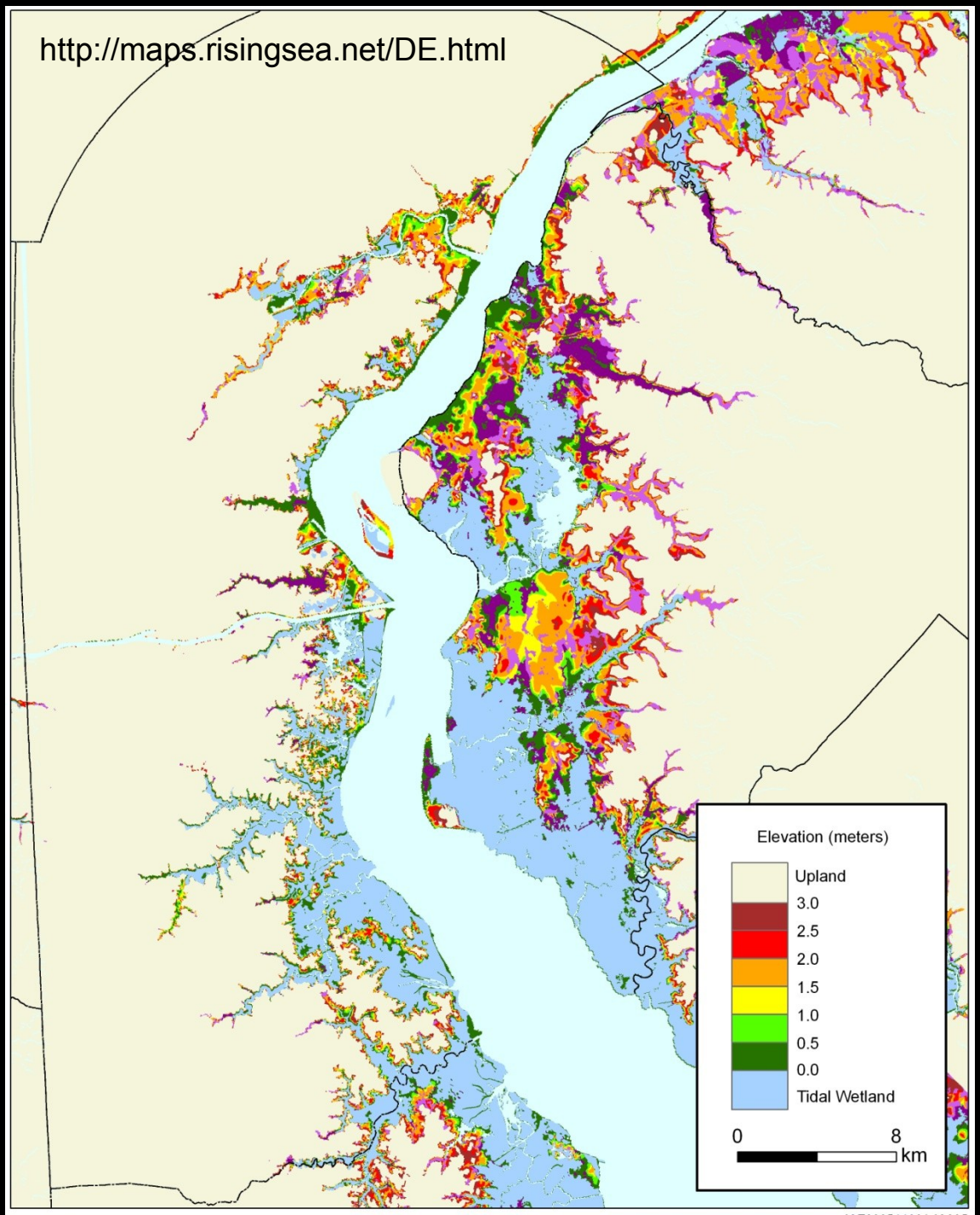
Tidal Wetland
0
8
km
http://maps.risingsea.net/DE.html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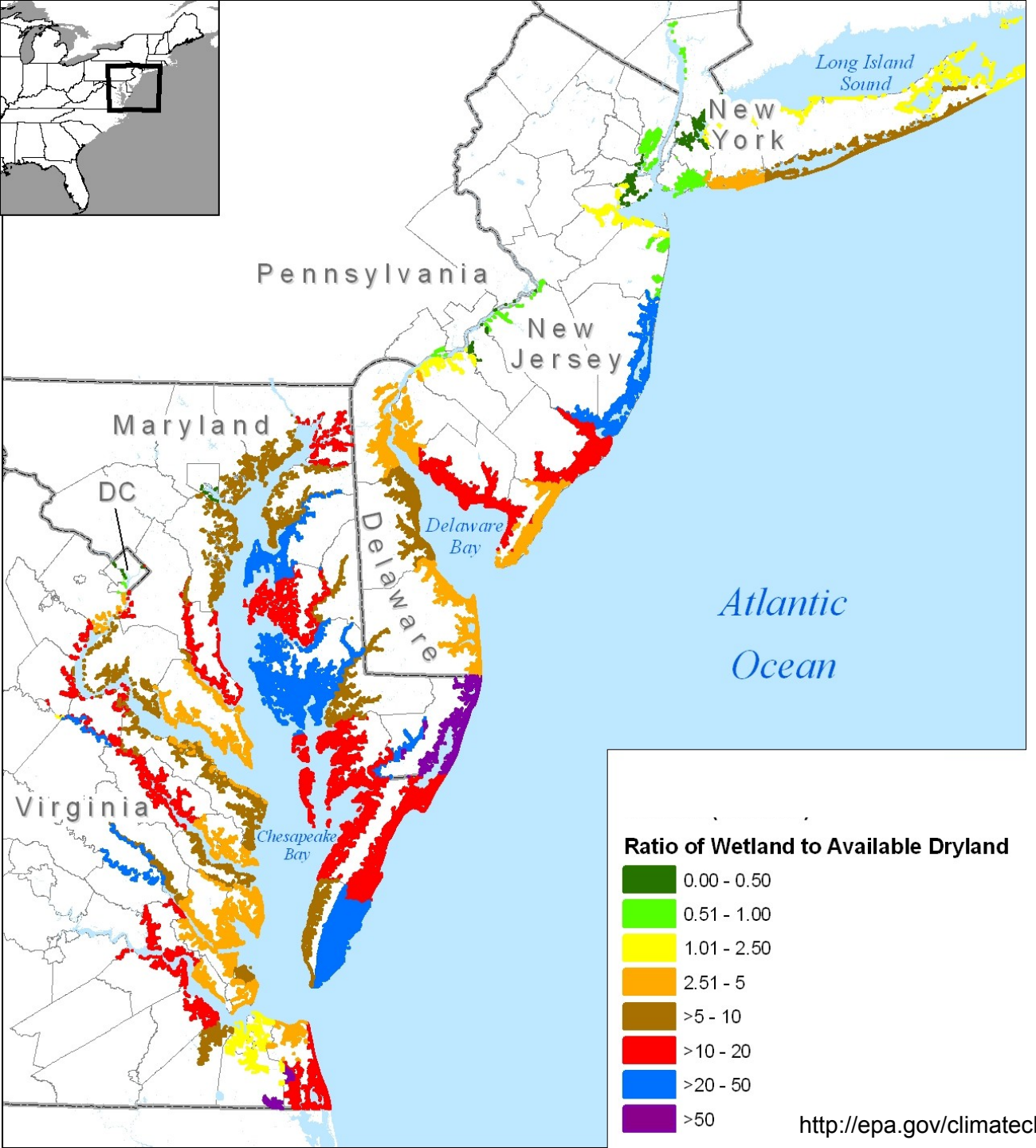


The amount of low land just above the wetlands is a small fraction of the area of tidal wetlands

http://epa.gov/climatechange/effects/coastal/section1_1_may2008.pdf

Three Responses to Sea Level Rise

- Retreat
- Hold Back the Sea:
  - Armor the Shore (dikes, seawalls, bulkheads, rip-rap) *or*
  - Elevate Everything

Coastal Sensitivity to Sea-Level Rise:
A Focus on the Mid-Atlantic Region

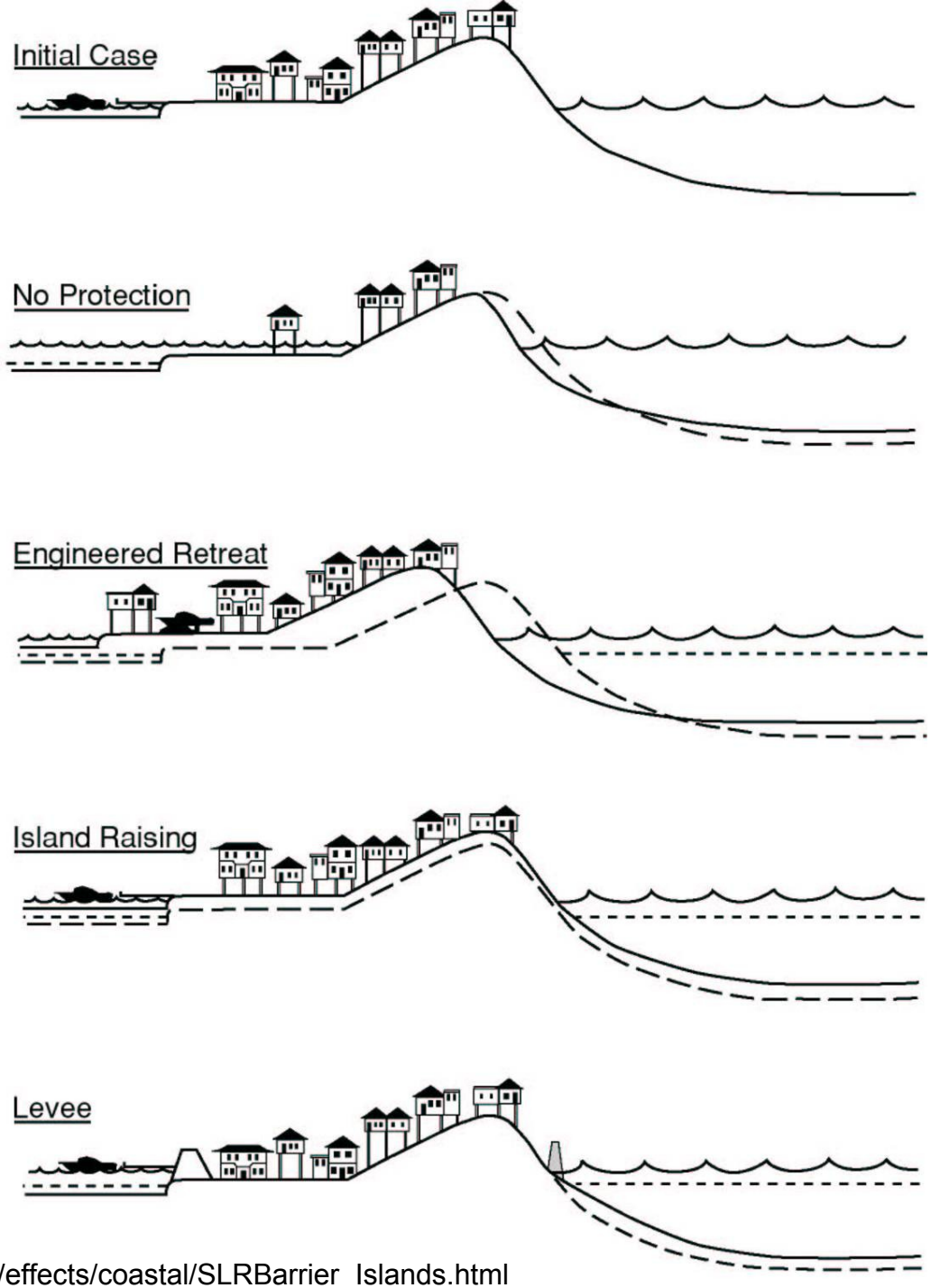
U.S. Climate Change Science Program
Synthesis and Assessment Product 4.1

PART II
Societal Impacts and Implications

Chapters 6: Protection and Retreat

- **Fundamental Pathways for responding to sea level rise:**
  - **Shoreline armoring**
  - **Elevate land, structures, wetlands**
  - **Retreat**

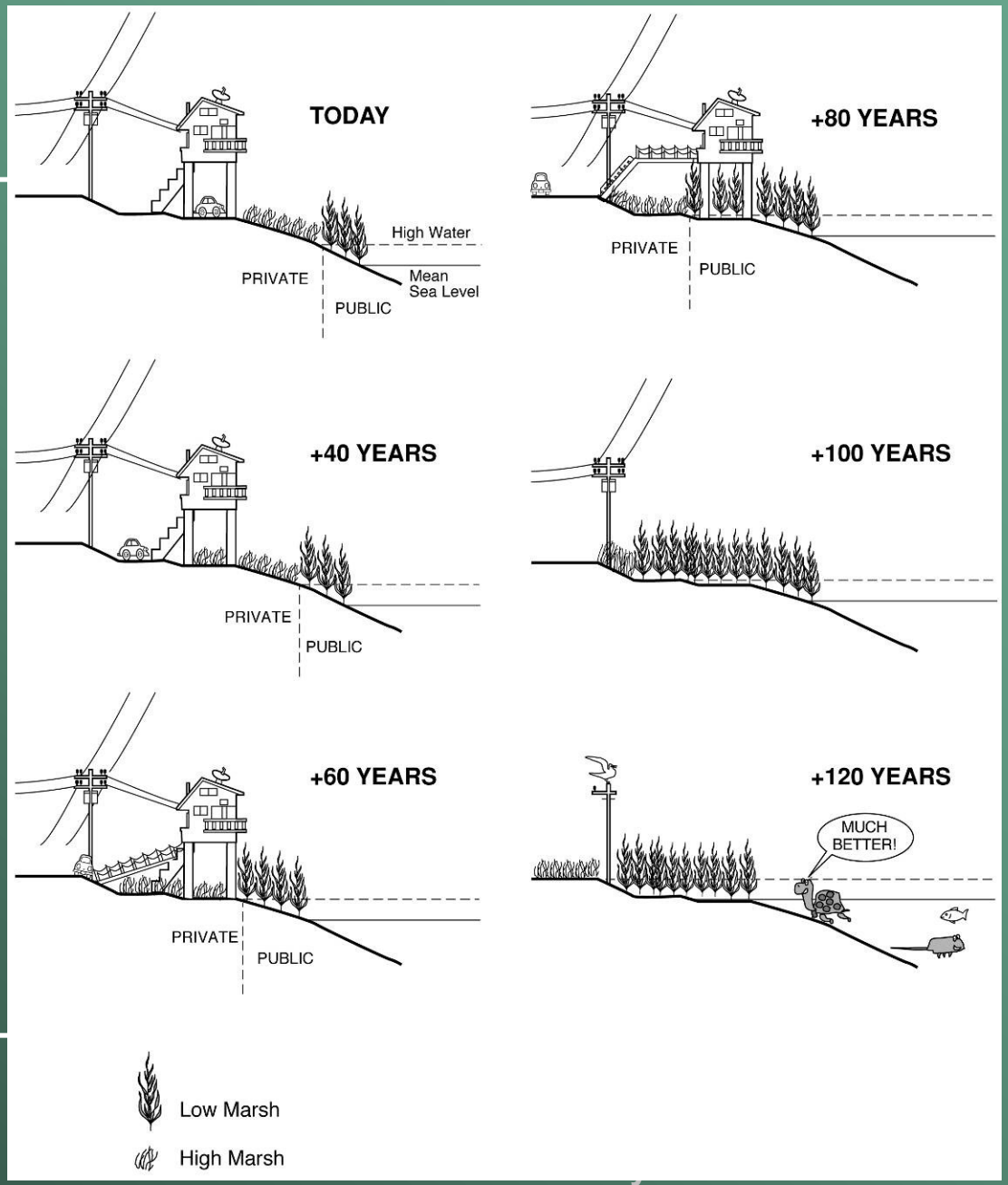
- **Tradeoffs between different approaches**
  - **Shore protection maintains existing land use**
  - **Retreat allows natural processes**
  - **Costs and social implications vary.**
  - **Higher rates may shift the balance toward retreat**



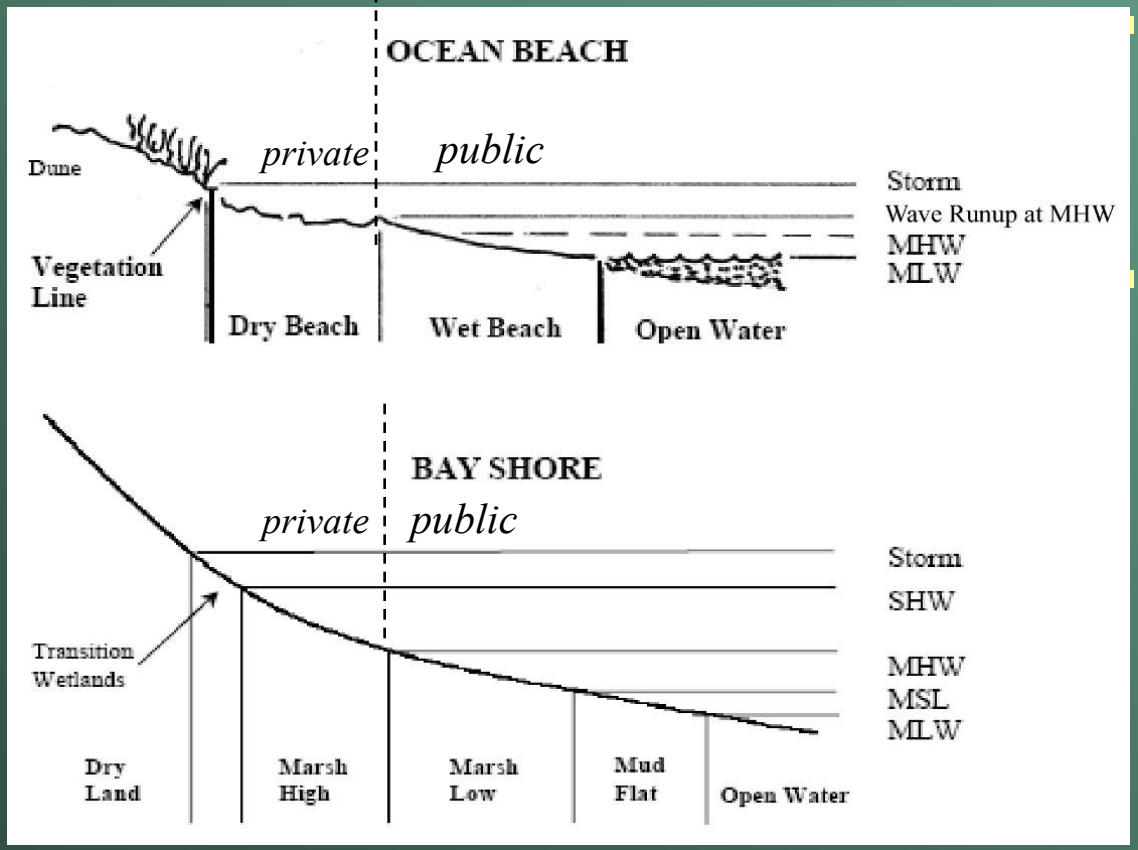
http://epa.gov/climatechange/effects/coastal/SLRBarrier_Islands.html

Rolling Easement

An interest in land (or a rule of law) under which the landward migration of wetlands, beaches, and public access along the shore has the right of way over a property owner's preference to hold back the sea.



Chapter 8: Public Access



- **Publicly funded beach nourishment promotes public access to and along the shore**
- **Shoreline armoring usually eliminates intertidal zone:**
  - **Existing public access along the shore eliminated**
  - **New Jersey regulation requiring path inland of the armoring.**


Source: http://risingsea.net

PART III
Preparing for Sea-Level Rise

Three Questions

- For which decisions is anticipating sea level rise logically justified (Chapter 9)
- What are organizations doing to prepare? (Chapter 10)
- What are the institutional barriers? (Chapter 11)

Development, Protection, and Moral Hazard

Anticipating Sea Level Rise is Logically Justified

- Sea level rise changes merits of
  - Shore protection
  - Home elevation
  - Coastal development
- Flood insurance
  - Can ensure that risks are reflected in the cost of coastal habitation
  - key tool for ensuring safe construction (e.g. floor elevation)

Institutional Biases:

- Policies encourage coastal development
  - Local policies
  - Development a route to federal subsidies
- Federal safety net for development
  - Subsidized shore protection
  - FEMA programs that pay for shore protection, home elevation, relocation
- Flood Insurance
  - Grandfathering of assumed risk:
  - Sea level rise not included in flood mapping.

Coastal Habitat

Anticipating Sea Level Rise is Logically Justified

- Vacant land for migration
- Planning tools have long lead times
- Shoreline armoring taking place where living shorelines would work
- Opportunities to preserve existing wetlands through engineering

Institutional Biases Include:

- Federal wetlands protection statutes do not consider habitat migration
- Nationwide permit for hard structures
- Industry practices favor hard structures

Progress: Maryland recently passed a living shoreline statute and other states are considering the issue

Structures with long expected lifetimes

Anticipating Sea Level Rise is Logically Justified

- Designing structures to address sea level rise less expensive than later retrofit
- Some infrastructure may not be in the correct location

Institutional Barriers Include:

- Lack of clear plan as to whether specific areas will be protected or abandoned

Hard to Prepare Unless You Know Which Path You Are On

Decision:	Dike	Elevate	Retreat
Rebuild drainage systems	Checkvalves, holding tanks, pumps	No change needed	Install larger pipes, larger rights of way for ditches
Replace septics with public sewer	Extending sewer helps drainage	Mound; extending sewer okay	Extending sewer undermines policy; mounds system ok
Rebuild roads	Keep roads at same elevation; owners will not have to elevate lots	Rebuild road higher, motivate property owners to elevate	Elevate roads to facilitate evacuation
Location of roads	Shore-parallel road needed for dike maintenance	No change	Shore parallel road will be lost; all must have access to shore-perpendicular road,
Setbacks/ Subdivision	Setback from shore to leave room for dike	No change	Erosion-based setbacks
Shoreline Easements	Easement or option to purchase land for dike	No change	Rolling easements to ensure that wetlands and beaches migrate

Hard to Prepare Unless You Know Which Path You Are On

Decision:	Dike	Elevate	Retreat
Rebuild drainage system	Checkvalves, holding tanks, pumps	No change needed	Install larger pipes, larger rights of way for ditches
Replace septics with public sewer	Extending sewer helps drainage	Mounds; extending sewer okay	Extending sewer undermines policy; mounds system ok
New Road	Shore-parallel	No Change	Perpendicular
Rebuild roads	Keep roads at same elevation; homes need not elevate lots	Rebuild road higher, motivate property owners to elevate	Elevate roads: helps evacuation; but may harm public health